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US 1207034 A

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(54) Abstract Title: **Cyclonic separating apparatus**

(57) Cyclonic dust-collecting apparatus for use in (and used in) a vacuum cleaner comprises a first cyclone (111, fig. 1). Disposed around the outside of the first cyclone is a plurality of second cyclones (113, fig. 1) in parallel. A dust-collecting unit (165) is detachably connected to the first and second cyclones and collects dust form the first cyclone separately to dust separated by the second cyclones. An inlet-outlet cover (190) is installed on the upper portions of the first and second cyclones such that air flowing from the first cyclone's outlet (123) is guided towards the second cyclones' inlets (141). The dust-collecting apparatus has transparent wall sections such that a user may view the interior of each dust-collector. The first cyclone outlet may further be provided with a grille (131) and a shielding member (135) to enhance separation in the first stage.

FIG. 2

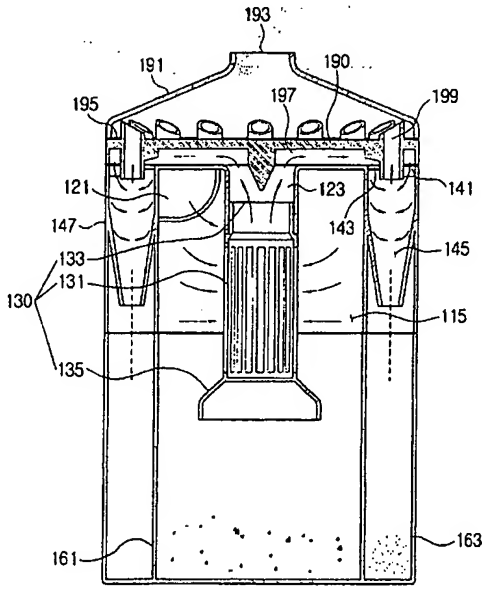

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FIG. 1

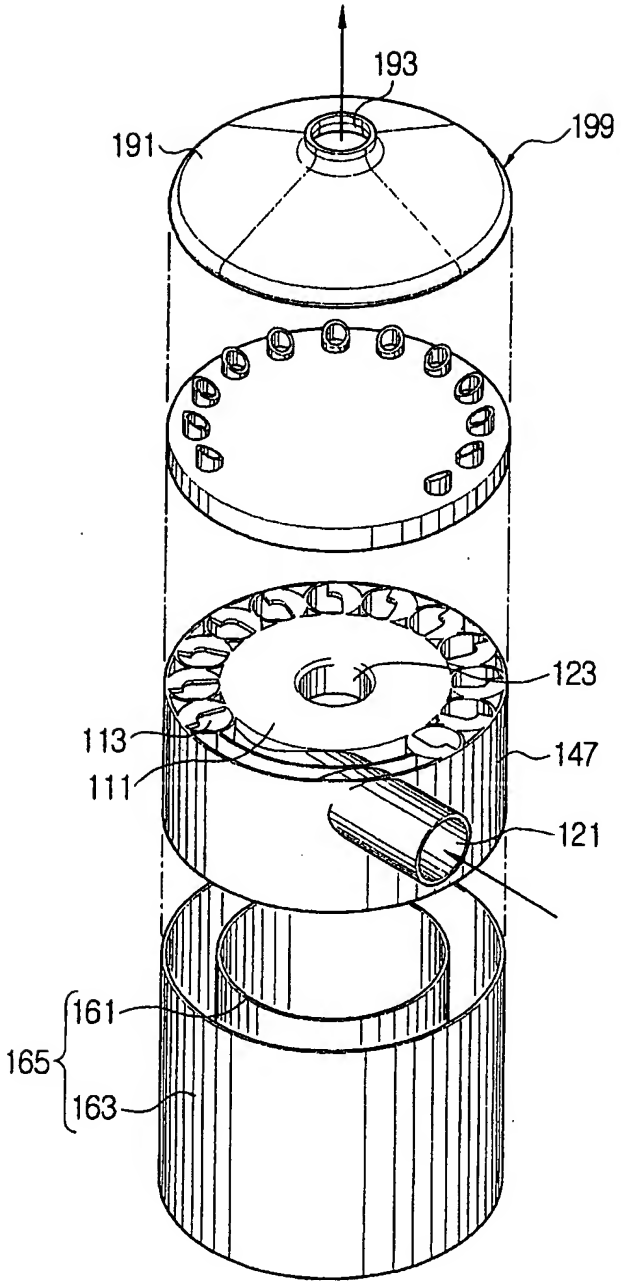
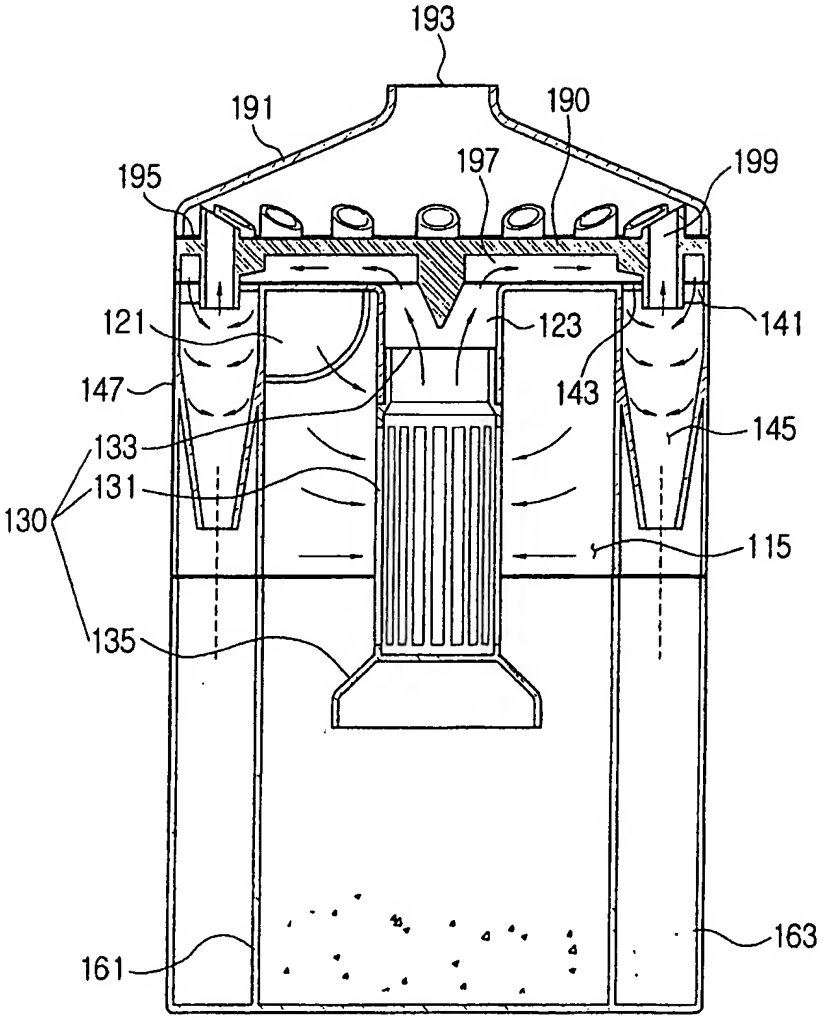


FIG. 2


193
191
190
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197
199
121
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141
147
143
145
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131
130
115
135
161
163

FIG. 3

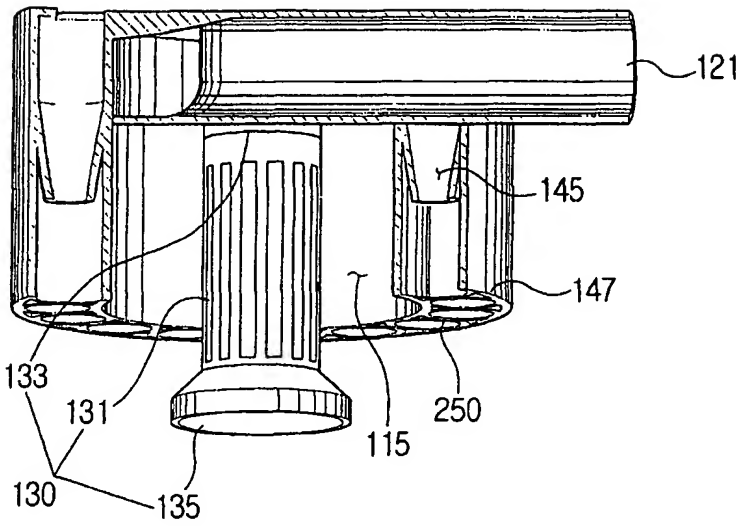


FIG. 4

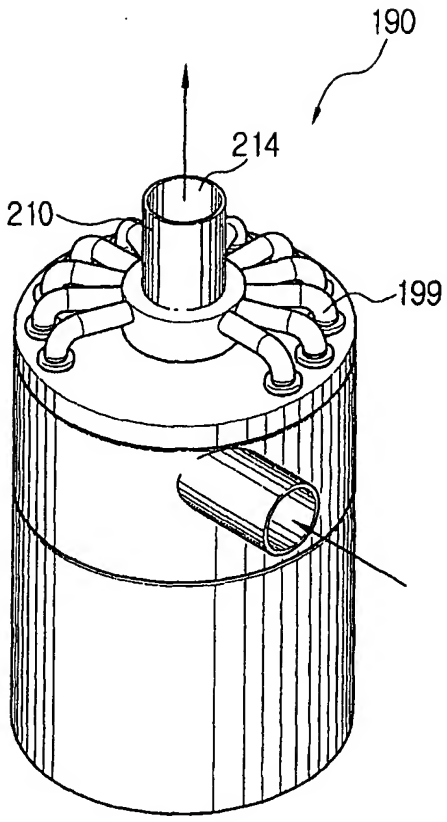


FIG. 5

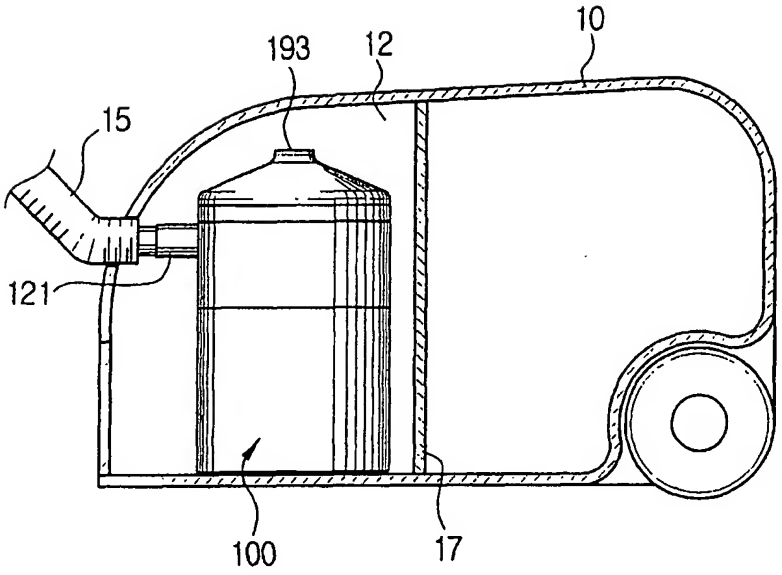
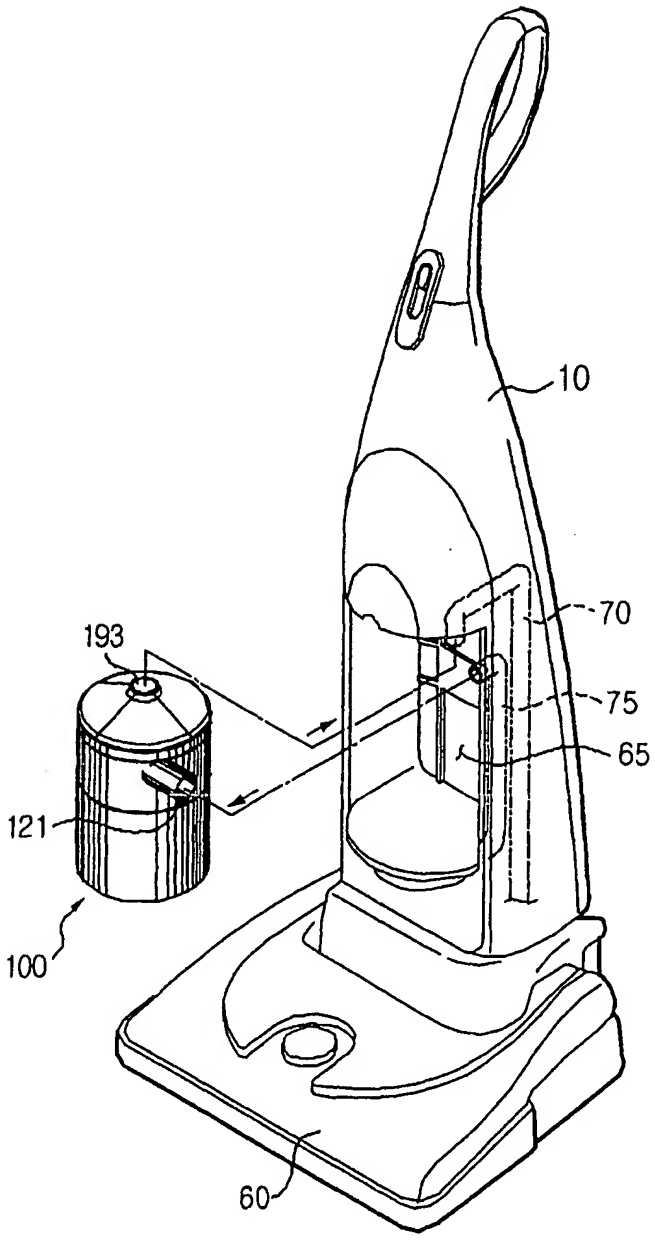


FIG. 6



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Cyclonic Separating Apparatus

This application is related to copending applications entitled "Cyclonic separating apparatus and Vacuum Cleaner having the same" (Korean Application No. 2003-63211, filed September 9, 2003), "Cyclone Dusting Separating Apparatus and Vacuum Cleaner having the same" (Korean Application No. 2003-63212, filed September 9, 2003), and "Cyclone Dusting Separating Apparatus and Vacuum Cleaner Equipped with the same" (Korean Application No. 2003-63213, filed September 9, 2003) whose disclosures are commonly owned by the same applicant as the present application and are entirely incorporated herein by reference.

This invention relates to a cyclonic separating apparatus and to a vacuum cleaner having the same, and in particular to a cyclonic separating apparatus comprising a first cyclone and a plurality of second cyclones in which the second cyclones are installed on the outer periphery of the first cyclone to enclose the first cyclone, and to a vacuum cleaner having the same.

Generally, a cyclonic separating apparatus is an apparatus for separating dust and dirt (hereinafter referred to as "dust") using centrifugal force by generating a rotational current inside a cyclone chamber, and is widely used in a variety of fields. U.S. Patents Nos. 3,425,192 and 4,373,228 disclose embodiments adopting such a cyclonic separating apparatus to a vacuum cleaner.

The above patents disclose a cyclonic dust-collecting apparatus for separating dust from air using a plurality of cyclones. Large dust particles are separated by a first cyclone, and the air from which such dust has been separated then flows into a second (auxiliary) cyclone. Accordingly, small dust particles are separated, and "clean" air is discharged to the outside. U.S. Patent No. 3,425,192 discloses that the auxiliary cyclone is arranged on the upper part of the first cyclone, so that large dust particles are separated by the first (main) cyclone, and partially-cleaned air flows into the auxiliary cyclone,

where small dust particles are then separated. U.S. Patent No. 4,373,228 discloses a plurality of auxiliary cyclone units which are installed inside the first cyclone.

The conventional cyclonic separating apparatus, however, has some problems. Firstly, since the connecting structure between the first cyclone and the auxiliary cyclone(s) is complicated, and a suction force generated within a main body of the vacuum cleaner is difficult to deliver, the suction force and cleaning efficiency deteriorates. Secondly, since the first cyclone and the auxiliary cyclone(s) are not compactly arranged, the cyclonic separating apparatus must be large if it is adequately to perform the dust-collecting function. Accordingly, a vacuum cleaner with such a cyclonic separating apparatus is bulky, difficult to maintain, and is inconvenient to use. Thirdly, since a connection path between the first cyclone and the auxiliary cyclone(s) is complicated, the production process is complicated. Therefore, the number of parts and hence the production cost is increased.

Thus, a heretofore unaddressed need exists in the industry to address the aforementioned deficiencies and inadequacies.

An aim of the invention is to provide a cyclonic separating apparatus with a compact structure that is capable of an improved dust-collecting efficiency, and also preventing deterioration of its suction force.

The present invention provides a cyclonic separating apparatus for a vacuum cleaner, the apparatus comprising:

a first cyclone for separating dust from drawn-in air; and

a plurality of second cyclones,

wherein the second cyclones are installed around the outer periphery of the first cyclone so as to enclose the first cyclone.

In a preferred embodiment, the first cyclone comprises a first chamber for centrifugally separating dust from incoming dust-carrying air, a first inlet formed in the first chamber, into which first inlet dust-carrying air flows, and a first outlet formed in the

first chamber, from which first outlet air is discharged. The first chamber may be cylindrical.

The first cyclone may further comprise a grille positioned inside the cyclone chamber and installed upstream of the first outlet to prevent dust separated from drawn-in air flowing backwards through the first outlet.

Preferably, the grille comprises:

a grille body having a plurality of channels;

a grille opening formed at one side of the grille body, for discharging air from which dust has been separated, the grille opening communicating with the first outlet; and

a shield formed at the other side of the grille body, for preventing dust from flowing backwards.

Advantageously, each of the second cyclones comprises:

a second chamber for centrifugally separating dust from air supplied by the first cyclone;

a second inlet formed in the second chamber, into which second inlet air discharged from the first cyclone flows; and

a second outlet formed in the second chamber, for discharging air from which dust has been separated. Conveniently, one end portion of the second chamber is frustoconical.

Preferably, the apparatus further comprises an inlet-outlet cover installed on upper parts of the first and second cyclones, the inlet-outlet cover providing fluid communication between the first outlet of the first cyclone and the second inlets of the second cyclones. Conveniently, the inlet-outlet cover has an air channel connecting the first outlet and the second inlets, and a plurality of outlet channels for communicating with the second outlets of the second cyclones.

Advantageously, a predetermined portion of each outlet channel is inserted into an outlet of the respective second cyclone when the inlet-outlet cover is positioned over the second cyclones, so that air is discharged through the outlet channels. Preferably, one end of each outlet channel is connected to the outlet of the respective second cyclone, and the other end is upwardly open. The inlet-outlet cover may further comprise a central outlet for allowing air discharged from each of the outlet channels to form a single discharge current.

Preferably, the upper part of the outlet is formed with an exit opening.

In a preferred embodiment, the apparatus further comprises a cyclone cover installed on an upper part of the inlet-outlet cover. Preferably, the cyclone cover is substantially frustoconical with open upper and lower ends.

Preferably, the first cyclone is integrally formed with each of the second cyclones. Advantageously, the apparatus further comprises a partition defining and separating the second cyclones.

The invention also provides a vacuum cleaner comprising:

a vacuum cleaner main body for generating a suction force to draw in dust-carrying air;

a nozzle unit for drawing in dust from a surface to be cleaned using the suction force, the nozzle unit being in fluid communication with the vacuum cleaner main body; and

a cyclonic separating apparatus in the vacuum cleaner main body,

wherein the cyclonic separating apparatus comprises a first cyclone and a plurality of second cyclones for separating dust from the drawn-in air, the second cyclones being installed around an outer periphery of the first cyclone thereby to enclose the first cyclone.

Preferably, the first cyclone comprises:

a first chamber for centrifugally separating dust from incoming dust-carrying air;

a first inlet formed in the first chamber, into which first inlet dust-carrying air flows; and

a first outlet formed in the first chamber, from which first outlet air is discharged.

Advantageously, each of the second cyclones comprises:

a second chamber for centrifugally separating dust from air supplied by the first cyclone;

a second inlet formed in the second chamber, into which second inlet air discharged from the first cyclone flows; and

a second outlet formed in the second chamber, for discharging air from which dust has been separated.

Other systems, methods, features, and advantages of the present invention will be or become apparent to one skilled in the art upon examination of the following drawings and detailed description. It is intended that all such additional systems, methods, features, and advantages included within this description, be within the scope of the present invention, and be protected by the accompanying claims.

The invention will now be described in greater detail, by way of example, with reference to the drawings, in which:

Figure 1 is an exploded perspective view of the main part of a cyclonic separating apparatus constructed according to the present invention;

Figure 2 is a cross-sectional view of the cyclonic separating apparatus of Figure 1;

Figure 3 is a perspective cross-sectional view of the cyclonic separating apparatus of Figure 1;

Figure 4 is a perspective view a second form of a cyclonic separating apparatus constructed according to the present invention;

Figure 5 is a schematic cross-sectional view of a canister vacuum cleaner incorporating the cyclonic separating apparatus of Figure 1; and

Figure 6 is a schematic perspective view of an upright vacuum cleaner incorporating the cyclonic separating apparatus of Figure 1.

Referring to the drawings, Figure 1 shows a cyclonic separating apparatus 100 having a first cyclone 111, a plurality of second cyclones 113, an inlet-outlet cover 190 installed on the upper parts of the first and second cyclones 113, a cyclone cover 191, and a dust-collecting unit 165. The second cyclones 113 are installed around the outer periphery of the first cyclone 111, thereby enclosing the first cyclone. The first cyclone 111 is integrally formed with each of the second cyclones 113, a partition 250 defining and separating the second cyclones 113, as shown in Figure 3. A cylindrical chamber wall 147 is formed around the second cyclones 113. The chamber wall 147 can take a variety of shapes depending on the shape of the recess into which the chamber wall is received in a vacuum cleaner main body 10 (see Figures 5 and 6).

The first cyclone 111 (see Figure 2) comprises a first chamber 115, a first inlet 121, a first outlet 123, and a grille 130. The first chamber 115 is cylindrical, and separates dust from incoming dust-carrying air using the centrifugal force generated by a rotational air current. The grille 130 is installed upstream of the first outlet 123, to prevent dust separated from drawn-in air from flowing backwards through the first outlet 123. The grille 130 includes a grille body 131 having a plurality of channels, a grille opening 133, and a shield 135. The grille opening 133 is formed at one end of the grille body 131 to discharge partially-cleaned air through the first outlet 123. The shield 135 is formed at the other end of the grille body 131 to prevent the separated dust from flowing backwards.

Each second cyclone 113 includes a respective second chamber 145, a respective second inlet 141, and a respective second outlet 143. Each second chamber 145 is formed such that one end thereof is frustoconical, and separates dust from dust-carrying air using centrifugal force. Air discharged from the first cyclone 111 flows into the second inlets 141, and air separated by the second chambers 145 is discharged to the second outlets 143.

The inlet-outlet cover 190 is installed on the upper parts of the first and second cyclones 111 and 113, and includes an air channel 197 for fluid communication between the first outlet 123 of the first cyclone 111 and the second inlets 141 of the second cyclones 113,

and, outlet channels 199. The outlet channels 199 communicate with the second outlets 143 of the second cyclones 113. When the inlet-outlet cover 190 is in position, a portion of each outlet channel 199 is inserted into the respective outlet 143 so "clean" air can be discharged through the outlet channels, the other end of each outlet channel being upwardly-open towards the top of the inlet-outlet cover.

The cyclone cover 191 is frustoconical and is upwardly and downwardly open. The cyclone cover 191 is detachably disposed on the upper part of the inlet-outlet cover 190. The air discharged from the second outlets 143 of the second cyclones 113 accumulates in the cyclone cover 191, and is discharged to the outside of the cyclonic separating apparatus 100 through an upper opening 193 formed at the upper end of the cyclone cover.

The dust-collecting unit 165 includes a first dust-collecting container 161 and a second dust-collecting container 163. The first dust-collecting container 161 is formed integrally with the second dust-collecting container 163. The second dust-collecting container 163 is formed as a hollow cylinder, and is detachably connected to the chamber wall 147 formed on the outside of the second cyclones 113. The first dust-collecting container 161 is formed as a hollow cylinder, and is installed inside the second dust-collecting container 163, and is detachably connected to the first chamber 115 of the first cyclone 111.

Figure 4 shows a modified form of cyclonic separating apparatus, wherein the only difference is the shape of the inlet-outlet cover 190 which is such that the cyclone cover 191 is not required. Referring to Figure 4, the outlet channels 199 of the inlet-outlet cover 190 extend from the second outlets 143. One end of each outlet channel 199 is connected to the respective second outlet 143, the other ends of the outlet channels being connected to an outlet 210 at the centre of the inlet-outlet cover 190. An opening 214 is formed at the upper end of the outlet 210. Accordingly, a single discharge current passes through the outlet 210.

As shown in Figure 5, a dust-collecting chamber 12 is defined by a partition 17 formed in the main body 10 of a canister vacuum cleaner, the cyclonic separating apparatus 100 being positioned inside the dust-collecting chamber. The first inlet 121, which is formed in one side of the upper part of the periphery of the cyclonic separating apparatus 100, permits dust-carrying air to pass therethrough as air is drawn into the cyclonic separating apparatus through a flexible hose 15 of the vacuum cleaner by the suction force generated by a motor (not shown). The upper opening 193, which is formed in the central part of the upper end of the cyclonic separating apparatus 100, discharging air from which dust has been separated by centrifugal force.

The cyclonic separating apparatus 100 can also be incorporated in an upright vacuum cleaner. Thus, referring to Figure 6, a vacuum generating apparatus such as a motor (not shown) is provided in the main body 10 of the cleaner. A nozzle unit 60 is movably connected to the lower side of the main body 10, and a cyclone-receiving chamber 65 is provided in the front centre of the main body 10. An air suction channel 70 connected to the nozzle unit 60, and an air discharge channel 75 connected to the motor, are provided, these channels terminates in the cyclone receiving chamber 65.

The first inlet 121 of the cyclonic separating apparatus 100 communicates with the air suction channel 70, and the upper opening 193 communicates with the air discharge channel 75, so that dust is separated from dust-carrying air drawn-in through the nozzle unit 60, as it passes through the cyclonic separating apparatus. The "clean" air is discharged to the outside via the upper opening 193 and the air discharge channel 75.

The operation of the cyclonic separating apparatus 100 will now be described with reference to Figures 1 to 6.

As the suction force is generated in the main body 10, the nozzle unit 60 draws dust-carrying air from a surface to be cleaned, using the suction force. The drawn-in air flows into the first chamber 115 in a tangential direction along the first inlet 121, and large dust particles are separated from the air by the first cyclone 111 using the centrifugal force, the large dust particles being collected in the first dust-collecting

container 161. More specifically, the first cyclone 111 separates large dust particles from incoming dust-carrying air using the suction force generated by the motor in the vacuum cleaner main body 10. The first chamber 115 of the first cyclone 111 generates a centrifugal force by rotating air flowing in through the first inlet 121, along the inner wall of the first chamber in a tangential direction with respect to the first chamber. The air, being towards relatively light in weight, is less influenced by the centrifugal force, and so converges towards the central portion of the first chamber 115. It is then discharged in a whirling air current towards the first outlet 123. Dust being relatively heavier than air, is subjected to a larger centrifugal force, and so flows along the inner wall of the first chamber 115 to be collected in the first dust-collecting container 161.

Air, from which large dust particles have been separated, flows through the first outlet 123 of the first chamber 115, passes through the air channel 197, and tangentially flows into the second chambers 145 through the second inlets 141 of the second cyclones 113. Since the air channel 197 diverges radially from the centre, a large air stream from which dust has been separated is divided into small air streams. Accordingly, the dust separation process in the second cyclones 113 is easily performed. Air that has flowed into the second chambers 145 is further separated by the centrifugal force, so that small dust particles, are collected in the second dust-collecting container 163.

The partition 250, which is formed between the second cyclones 113, prevents dust from flowing backwards to some extent, and allows efficient dust collecting when the separated dust particles fall down into the second dust-collecting container 163.

After the second dust separation process using the centrifugal force, the air flows through the second outlets 143 of the second cyclones 113, passes along the outlet channels 199 of the inlet-outlet cover 190, converges along the cyclone cover 191, and is finally discharged through the upper opening 193 formed in the upper part of the cyclone cover (see Figure 2). Referring to Figure 4, air flows through the outlet channels 199 of the inlet-outlet cover 190, passes through the outlet 210, gathers into one air stream, and is finally discharged through the opening 214 of the outlet. Hence,

the second cyclones 113 separate fine dust particles from air from which dust was first separated in the first cyclone 111.

In either case, the cyclonic separating apparatus 100 improves dust-collecting efficiency by performing the primary separation process in the first cyclone 111, and performing the secondary separation process in a plurality of second cyclones 113.

In the cyclonic separating apparatus 100, the distance between the first outlet 123 of the first cyclone 111 and the second inlet 141 of the second cyclone 113 is reduced as compared to the cleaners of the related art, so that suction force deterioration is prevented, and dust-collecting efficiency is improved.

Air discharged from the cyclonic separating apparatus 100 is discharged to the outside through the vacuum cleaner main body 10.

As is apparent from the above, the conventional cyclonic separating apparatus has a problem of low dust-collecting efficiency, and was limited to some extent in terms of suction force efficiency. The second cyclones of the two forms of cyclonic separating apparatus described above are arranged along the outer periphery of the first cyclone, thereby resulting in a compact structure. Accordingly, deterioration of the suction force does not occur, and dust-collecting efficiency is improved. Therefore, since the structure is compact and occupies a smaller space without a deterioration in dust-collecting efficiency, a cyclonic separating apparatus, and a vacuum cleaner with the same, can be provided that are satisfactory from the viewpoint of the user, thus raising product competitiveness.

While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood, by those skilled in the art, that various changes in form and details may be made without departing from the spirit and scope of the invention as defined by the appended claims. Therefore, all such proper modifications, changes and equivalents of the embodiments of the present invention will fall within the scope of the invention.

Claims

1. A cyclonic separating apparatus for a vacuum cleaner, the apparatus comprising:

a first cyclone for separating dust from drawn-in air; and

a plurality of second cyclones,

wherein the second cyclones are installed around the outer periphery of the first cyclone so as to enclose the first cyclone.

2. Apparatus as claimed in claim 1, wherein the first cyclone comprises:

a first chamber for centrifugally separating dust from incoming dust-carrying air;

a first inlet formed in the first chamber, into which first inlet dust-carrying air flows; and

a first outlet formed in the first chamber, from which first outlet air is discharged.

3. Apparatus as claimed in claim 2, wherein the first chamber is cylindrical.

4. Apparatus as claimed in claim 2 or claim 3, wherein the first cyclone further comprises a grille installed upstream of the first outlet of the cyclone chamber to prevent dust separated from drawn-in air from flowing back through the first outlet.

5. Apparatus as claimed in claim 4, wherein the grille comprises:

a grille body having a plurality of channels;

a grille opening formed at one side of the grille body, for discharging air from which dust has been separated, the grille opening communicating with the first outlet; and

a shield formed at the other side of the grille body, for preventing dust from flowing backwards.

6. Apparatus as claimed in any one of claims 2 to 5, wherein each of the second cyclones comprises:

a second chamber for centrifugally separating dust from air supplied by the first cyclone;

a second inlet formed in the second chamber, into which second inlet air discharged from the first cyclone flows; and

a second outlet formed in the second chamber, for discharging air from which dust has been separated.

7. Apparatus as claimed in claim 6, wherein one end portion of each second chamber is frustoconical.

8. Apparatus as claimed in any one of claims 1 to 7, further comprising an inlet-outlet cover installed on upper parts of the first and second cyclones, the inlet-outlet cover providing fluid communication between the first outlet of the first cyclone and the second inlets of the second cyclones.

9. Apparatus as claimed in claim 8, wherein the inlet-outlet cover has an air channel connecting the first outlet and the second inlets, and a plurality of outlet channels for communicating with the second outlets of the second cyclones.

10. Apparatus as claimed in claim 9, wherein a predetermined portion of each outlet channel is inserted into an outlet of the respective second cyclone when the inlet-outlet cover is positioned over the second cyclones, so that air is discharged through the outlet channels.

11. Apparatus as claimed in claim 10, wherein one end of each outlet channel is connected to the outlet of the respective second cyclone, and the other end is upwardly open.

12. Apparatus according to claim 11, wherein the inlet-outlet cover further comprises a central outlet for allowing air discharged from each of the outlet channels to form a single discharge current.

13. Apparatus as claimed in claim 12, wherein the upper part of the outlet is formed with an exit opening.

14. Apparatus as claimed in any one of claims 8 to 11, further comprising a cyclone cover installed on an upper part of the inlet-outlet cover.

15. Apparatus as claimed in claim 14, wherein the cyclone cover is substantially frustoconical with open upper and lower ends.

16. Apparatus as claimed in any one of claims 1 to 15, wherein the first cyclone is integrally formed with each of the second cyclones.

17. Apparatus as claimed in any one of claims 1 to 16, further comprising partition defining and separating the second cyclones.

18. A vacuum cleaner comprising:

a vacuum cleaner main body for generating a suction force to draw in dust-carrying air;

a nozzle unit for drawing in dust from a surface to be cleaned using the suction force, the nozzle unit being in fluid communication with the vacuum cleaner main body; and

a cyclonic separating apparatus in the vacuum cleaner main body,

wherein the cyclonic separating apparatus comprises a first cyclone and a plurality of second cyclones for separating dust from the drawn-in air, the second cyclones being installed around an outer periphery of the first cyclone thereby to enclose the first cyclone.

19. A vacuum cleaner as claimed in claim 18, wherein the first cyclone comprises:

a first chamber for centrifugally separating dust from incoming dust-carrying air;

a first inlet formed in the first chamber, into which first inlet dust-carrying air flows; and

a first outlet formed in the first chamber, from which first outlet air is discharged.

20. A vacuum cleaner as claimed in claim 18 or claim 19, wherein each of the second cyclones comprises:

a second chamber for centrifugally separating dust from air supplied by the first cyclone;

a second inlet formed in the second chamber, into which second inlet air discharged from the first cyclone flows; and

a second outlet formed in the second chamber, for discharging air from which dust has been separated.

INVESTOR IN PEOPLE

Application No: GB0412903.7 **Examiner:** Mr Jason Scott

Claims searched: 1-18 **Date of search:** 28 October 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,Y	X: 1-3, 6, 7 & 16-19; Y: 4 & 5	US 1207034 A POLYSIUS GmbH See whole document and in particular the first cyclone 5 and surrounding secondary cyclones 11 in the figure.
X,Y	X: 1-3, 6, 7, 18 & 19; Y: 4 & 5	GB 835884 A NAYLOR See whole document and in particular the first cyclone 12 and surrounding secondary cyclones 19 in the figures.
Y	4 & 5	GB 2377656 A SAMSUNG See grille 100.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{W} :

Worldwide search of patent documents classified in the following areas of the IPC^{07}

A01B; B04C

The following online and other databases have been used in the preparation of this search report

WPI, JAPIO, EPODOC